

**Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, D.C. 20554**

In the Matter of

The Establishment of Policies and  
Service Rules for the Non-Geostationary  
Satellite Orbit, Fixed Satellite Service  
in the Ku-Band

IB Docket No. 01-96

**REPLY COMMENTS OF  
THE BOEING COMPANY**

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## SUMMARY

Boeing supports the spectrum-sharing plan set forth in Option III of the *NPRM* – Avoidance of In-Line Interference Events – as the preferred method of sharing between NGSO FSS systems. The vast majority of NGSO FSS applicants expressed support for the Commission’s Option III approach. In fact, every applicant that expressed a preference, indicated that the Option III approach should be used for non-homogeneous satellite networks.

Boeing opposes any proposal to segment the Ku-band between homogeneous and non-homogeneous satellite networks. Such band segmentation would do nothing to facilitate spectrum sharing since none of the applicants in this proceeding have proposed homogeneous constellations. Band segmentation could also compromise the viability of satellite networks that will need access to all of the available spectrum. Finally, band segmentation is unnecessary because all of the proposed systems can use either satellite diversity or frequency avoidance to operate across the entire band using the Option III approach.

Boeing continues to endorse the definition of in-line interference that was proposed in the Commission’s *NPRM* – that the threshold for in-line interference be six percent of total system noise power under clear-sky conditions. Boeing acknowledges, however, that ITU-R Working Party 4A (“WP 4A”) is currently studying potential methodologies for interference calculations involving multiple NGSO FSS networks. The results of these studies could provide a valuable contribution to the Commission’s deliberations in this matter. Therefore, Boeing would support a Commission decision to adopt immediately rules that define an in-line interference event based on a set percentage of total system noise power, but refrain from incorporating into its rules a specific percentage (or percentages) of noise power until the WP 4A studies are completed and available for Commission review.

Boeing supports the Commission's proposal to refrain from mandating a reference antenna pattern for NGSO FSS user earth stations because it would impose unnecessary design limitations on antennas without providing significant improvements in sharing. Boeing also supports the Commission's tentative conclusion that it should not mandate off-axis e.i.r.p. limits for NGSO FSS licensees. Such limits are unnecessary to protect co-frequency networks, particularly if the Commission adopts its Option III sharing plan, which limits the interference that NGSO FSS networks can cause to co-frequency systems.

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The Boeing Company (“Boeing”), by its attorneys and pursuant to Section 1.415 of the Commission’s Rules, 47 C.F.R. § 1.415 (2000), hereby provides reply comments on the policies and service rules proposed for the non-geostationary satellite orbit, fixed satellite service (“NGSO FSS”) in the Ku-band, as requested by the recent Notice of Proposed Rulemaking in this docket.<sup>1</sup>

**I. THE COMMISSION SHOULD ADOPT THE NGSO SPECTRUM SHARING APPROACH THAT IS SUPPORTED BY ALMOST ALL OF THE APPLICANTS.**

In response to the Commission’s *NPRM* on NGSO FSS spectrum sharing, the NGSO FSS applicants expressed overwhelming support for the Commission’s third spectrum sharing option – Avoidance of In-line Interference Events. Of the five applicants that expressed a preference, four of them supported the use of Option III to promote spectrum sharing between NGSO FSS

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<sup>1</sup> *Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-Band*, IB Docket No. 01-96, Notice of Proposed Rulemaking, FCC 01-134 (May 3, 2001) (“*NPRM*”).

networks.<sup>2</sup> Furthermore, all five of the applicants expressed support for using Option III for non-homogeneous satellite systems.

In addition to this overwhelming expression of support, the Commission should adopt Option III because it furthers each of the Commission's goals for sharing between NGSO FSS networks. The Commission's spectrum sharing goals include:

1. ensuring that all applicants have equal access to spectrum,
2. preventing spectrum warehousing by non-implemented NGSO FSS systems at the expense of operational systems, and
3. adopting a spectrum sharing plan that permits operators to share cooperatively their respective spectrum assignments.<sup>3</sup>

By licensing every NGSO FSS network to operate across the entire spectrum band, Option III ensures that all applicants have equal access to spectrum. Only one applicant indicated in its comments that it would have difficulty operating across the entire band using the Option III approach. Virtual Geo objected to the In-Line Avoidance spectrum sharing technique, claiming that it would be too expensive for Virtual Geo to launch enough satellites to employ satellite diversity.<sup>4</sup> Virtual Geo also argued that in order to employ In-Line Avoidance all of the applicants would be forced to use uniform transmitter powers, which would be difficult for Virtual Geo's elliptical orbit satellite network.<sup>5</sup>

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<sup>2</sup> The sixth applicant, Hughes, indicated that it did not have enough information at its disposal to form an opinion on the subject. *See Hughes Comments* at 6.

<sup>3</sup> *See NPRM*, ¶¶ 17-19.

<sup>4</sup> *See id.* at 20.

<sup>5</sup> *See id.*

Neither of Virtual Geo's objections is persuasive, however. First, Virtual Geo provides no technical basis for its claim that NGSO FSS networks must have uniform transmitter powers in order to employ In-Line Avoidance. While uniform transmitter powers might make co-frequency sharing easier, uniform power levels certainly are not essential. This is particularly true if the Commission adopts a definition for in-line events that is based on a set level of interference (such as the 6% criteria proposed in the *NPRM*), rather than a definition based on a particular avoidance angle.

Second, while Virtual Geo has repeatedly indicated that it would prefer to not employ satellite diversity in its network design, Virtual Geo has failed to explain why its satellite system cannot employ frequency avoidance in order to operate co-frequency with non-homogeneous satellite systems.<sup>6</sup> Virtual Geo appears to acknowledge the merits of frequency avoidance, citing to its own studies, which indicate that simultaneous in-line events between more than two satellites from different NGSO FSS networks would be extremely rare.<sup>7</sup> As a result, NGSO FSS networks employing frequency avoidance would usually have access to the full 1000 MHz of spectrum in each direction, and would almost never have access to less than 500 MHz of spectrum in each direction. Such a prospect is far more desirable than a band segmentation option (such as Option IV), which, when fully deployed, would never give NGSO FSS networks access to more than 500 MHz of spectrum for their operations.

Additionally, the Commission should also adopt its Option III approach because it ensures that non-implemented NGSO FSS networks will be unable to warehouse spectrum at the

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<sup>6</sup> See *NPRM*, ¶ 30 (noting the possibility of using frequency avoidance to mitigate interference).

<sup>7</sup> See *Virtual Geo Comments* at 21-22 n.22.

expense of operational systems. The Option III solution also protects non-operational systems from spectrum warehousing by other non-operational systems. This element cannot be overstated because one of the most difficult steps in launching a major satellite network is securing the financing necessary for the venture. In order to secure financing, satellite operators must demonstrate to the investment community that the risks of the project have been minimized as much as possible. The In-Line Avoidance option helps to minimize risks for investors by guaranteeing that any NGSO FSS operator that launches its system will have primary access to the entire spectrum band. In contrast, all of the other options that have been proposed increase risks for investors because a prospective satellite operator will not be certain whether it will have primary access to all of the spectrum, or just a fraction of the band.

Finally, the Commission should adopt its Option III approach because it enables NGSO FSS licensees to share cooperatively their respective spectrum assignments. Each NGSO FSS applicant will have substantial flexibility in determining how it will mitigate interference while operating across the band. As noted in the *NPRM*, satellite operators can employ either satellite diversity or frequency avoidance in order to share spectrum with other satellite networks.<sup>8</sup> This flexibility permits network designers to customize their constellations to best serve their chosen business models. A network operator may choose to employ satellite diversity if the operator needs fulltime access to all of the available spectrum in every region of the world. At the same time, other operators can choose frequency avoidance if they desire a less expensive network in order to target different consumer markets. Operators may also incorporate a scaled approach to

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<sup>8</sup> See *NPRM*, ¶ 30.



their network designs, permitting them to employ frequency avoidance for their initial operations, but converting to satellite diversity as their capacity needs increase.

In light of the significant flexibility provided by the Commission's Option III spectrum sharing approach, and in light of the fact that Option III enjoys overwhelming support among the NGSO FSS applicants, the Commission should promote the public interest by promptly adopting its third spectrum sharing option for NGSO FSS operations in the Ku-band.

## **II. IN EMPLOYING OPTION III, THE COMMISSION SHOULD ADOPT THE SHARING MECHANISM PROPOSED IN THE *NPRM*, WITH POSSIBLE ADJUSTMENT TO THE INTERFERENCE THRESHOLD.**

Boeing's comments endorsed the definition of in-line interference that was proposed in the Commission's *NPRM* – that the threshold for in-line interference be six percent of total system noise power under clear-sky conditions. The use of a six percent threshold would be equitable to all operators, as evidenced by its long-standing use as a coordination trigger for licensees of geostationary FSS networks.

Other NGSO FSS applicants also endorsed the use of an interference threshold that is based on a set percentage of total system noise power, rather than a particular separation angle between satellites.<sup>9</sup> Some of these applicants, however, argued that because of the time varying nature of interference from NGSO FSS satellites, it might be appropriate to define in-line interference using a different percentage of system noise power, such as an aggregate limit of ten percent, with smaller single entry limits when three or more networks are in operation.<sup>10</sup>

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<sup>9</sup> See *Teledesic Comments* at 7; *Virtual Geo Comments* at 21-22 n.22.

<sup>10</sup> See *Teledesic Comments* at 5-7; see also *Virtual Geo Comments* at 27-28.

Boeing is aware that ITU-R Working Party 4A (“WP 4A”) is currently studying potential methodologies for interference calculations involving multiple NGSO FSS networks. These studies are considering the use of an aggregate ten percent threshold, with smaller single entry thresholds for sharing situations involving three or more networks. Boeing believes that the results of these studies could provide a valuable contribution to the Commission’s deliberations in this matter. Therefore, Boeing would support a Commission decision to adopt immediately rules that define an in-line interference event based on a set percentage of total system noise power, but refrain from incorporating into its rules a specific percentage (or percentages) of noise power until the WP 4A studies are completed and available for Commission review. Furthermore, prior to establishing one or more specific percentages of total system noise power for NGSO/NGSO in-line interference, the Commission should provide NGSO FSS applicants with an opportunity to comment on the results of the WP 4A study process.

### **III. THE COMMISSION SHOULD DISREGARD HUGHES’ REQUEST FOR OPEN-ENDED DELAY IN THIS PROCEEDING.**

Despite more than four years of intensive study and consideration, Hughes argues in its comments that none of the NGSO FSS applicants is in a position to recommend a spectrum sharing option for multiple NGSO FSS networks in the Ku-band.<sup>11</sup> Hughes argues that the applications pending before the Commission for NGSO FSS systems do not provide adequate technical detail “to unequivocally recommend and commit to a licensing approach.”<sup>12</sup> While

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<sup>11</sup> See *Hughes Comments* at 6.

<sup>12</sup> See *id.* at 6.

Boeing agrees that many of the pending applications lack significant technical detail,<sup>13</sup> Boeing does not believe that the failure of some applicants should suspend progress for remaining applicants.

Hughes also suggests that, rather than select a spectrum sharing option immediately, the Commission should encourage applicants to engage in additional negotiations on spectrum sharing.<sup>14</sup> Hughes argues that such negotiations could produce a spectrum sharing plan that more adequately reflects the particular needs of each applicant.<sup>15</sup> In making this argument, Hughes fails to acknowledge that the adoption of the Commission's Option III approach would not only encourage, but would require, applicants to conduct additional negotiations regarding interference mitigation.<sup>16</sup> Furthermore, if the Commission adopts Option III, it would give future spectrum sharing negotiations a clear structure and agenda that was noticeably absent from previous negotiations involving all of the applicants. Such structure would help participants in future negotiations to reach consensus on the types of customized spectrum sharing arrangements that Hughes indicates would be most desirable in order to ensure the most efficient use of the spectrum.

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<sup>13</sup> See *Consolidated Petitions to Deny or Hold in Abeyance of The Boeing Company*, SAT-AMD-19980630-00056 S2241, *et al.*, at 5-17 (June 30, 1999) (arguing that the Commission should dismiss the applications of Hughes, Teledesic, Virtual Geo and Denali for failing to comply with the basic application filing requirements of Section 25.114 and other sections of the Commission's rules).

<sup>14</sup> See *Hughes Comments* at 4.

<sup>15</sup> See *id.*

<sup>16</sup> See *NPRM*, ¶ 32 (indicating that the Option III approach would require NGSO FSS operators to complete coordination with all other operational NGSO FSS systems regarding the combination of interference mitigation techniques that will be employed to avoid in-line interference events).

#### **IV. VIRTUAL GEO'S APPROACH DOES NOT FURTHER THE COMMISSION'S GOALS IN THIS PROCEEDING.**

While Virtual Geo acknowledges the Commission's goals in this proceeding, Virtual Geo's suggests a spectrum sharing plan that would not further these goals.<sup>17</sup> Virtual Geo proposes a "compromise" that would essentially give Virtual Geo sole access to half the assigned spectrum while the remaining six systems would share the remaining half of the assigned spectrum.<sup>18</sup>

First, Virtual Geo's proposal would not further the Commission's goal of ensuring that all applicants have equal access to spectrum. Virtual Geo attempts to refute this by arguing that other applicants could use its spectrum assignment if they adopt its patented orbital constellation.<sup>19</sup> To date, however, no other applicant has voiced an interest in adopting Virtual Geo's elliptical orbit constellation design.

Second, Virtual Geo's plan does not further the Commission's goal of preventing spectrum warehousing. Instead, Virtual Geo's proposal would likely result in leaving more than half the available spectrum fallow (either as growth zone spectrum, or exclusive Virtual Geo spectrum). Virtual Geo argues that non-Virtual Geo networks would be able to operate on a secondary basis in Virtual Geo's spectrum until Virtual Geo's network comes into operation.<sup>20</sup>

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<sup>17</sup>See *Virtual Geo Comments* at 3 (citing *NPRM*, ¶¶ 17-19).

<sup>18</sup> Virtual Geo also proposes that a small portion of the spectrum remained unassigned for later use as a "growth zone." *Id.* at 7. Boeing opposes the use of a Growth Zone since it would increase uncertainty for NGSO FSS applicants regarding the amount of spectrum that will ultimately be available to accommodate their operations.

<sup>19</sup> See *id.* at 32-33, 36-37.

<sup>20</sup> See *id.* at 38.

Such an approach would create uncertainty for operators of NGSO FSS operators, however, because they would be unable to determine at the time of launch whether they would lose access to half the available spectrum as a result of the subsequent launch of Virtual Geo's network.

Third, Virtual Geo's spectrum sharing proposal disregards the Commission's goal of permitting operators to share cooperatively their respective spectrum assignments. Instead, Virtual Geo urges the Commission to bifurcate the band and effectively assign Virtual Geo exclusive access to nearly half the spectrum. Bifurcating the Ku-band would not only be inefficient, but is also entirely unnecessary. As noted in the previous section, the use of the Commission's "In-Line Avoidance Approach" could accommodate all the proposed satellite networks, including the constellation design proposed by Virtual Geo. Through the use of frequency avoidance, Virtual Geo could use Option III while making no changes to the size of its constellation, or its proposed satellite transmitter powers. Therefore the Commission should adopt its third spectrum sharing option for Ku-band NGSO FSS networks.

**V. THE COMMISSION SHOULD DISREGARD CLAIMS THAT GEOGRAPHIC COVERAGE REQUIREMENTS ARE UNNECESSARY.**

The Commission routinely requires NGSO satellite networks to comply with geographic coverage requirements in order to ensure that modern telecommunications services are available to all populations in every region of the world. Global coverage requirements are especially warranted in this proceeding because the total number of NGSO FSS networks that can operate in the Ku-band may not be unlimited. Furthermore, every additional system that launches creates "costs" for existing systems (either through the implementation of in-line avoidance techniques, or through the loss of spectrum capacity due to band segmentation). Therefore, in order to ensure that broadband services are made available in every region of the world, it is

important for the Commission to require the provision of global coverage as a condition of an applicant's license and due diligence milestones.

The only applicant that opposed geographic coverage requirements was Virtual Geo, which argued that such requirements are unnecessary because the provision of global coverage by other, yet unidentified, HEO satellite system applicants is “virtually guarantee[d].”<sup>21</sup> The Commission should disregard this illusory promise and enforce its proposed geographic coverage rules for all NGSO FSS systems authorized to provide services in the United States.

## **VI. THE COMMISSION DOES NOT NEED TO ADOPT REFERENCE ANTENNA PATTERNS FOR NGSO FSS TERMINALS.**

In agreement with most NGSO FSS applicants,<sup>22</sup> Boeing supports the Commission's proposal to refrain from mandating a reference antenna pattern for NGSO FSS user earth stations because it would impose unnecessary design limitations on antennas without providing significant improvements in sharing. Only Virtual Geo expressed support for the use of reference antenna patterns, and then only to enhance sharing between homogeneous satellite networks.<sup>23</sup> Since none of the NGSO FSS networks that have been proposed in this proceeding involve homogeneous constellations, no reason exists for the Commission to adopt a reference antenna pattern at this time.

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<sup>21</sup> *Id.* at 44.

<sup>22</sup> See *SkyBridge Comments* at 22; *Teledesic Comments* at 9; see also *Hughes Comments* at 17 (indicating that insufficient information is available to support the adoption of reference antenna patterns).

<sup>23</sup> See *Virtual Geo Comments* at 42-43.

**VII. THE COMMISSION SHOULD ALSO REFRAIN FROM ADOPTING OFF-AXIS E.I.R.P. LIMITS FOR NGSO FSS NETWORKS.**

Boeing also supports the Commission's tentative conclusion that it should not mandate off-axis e.i.r.p. limits for NGSO FSS licensees. Such limits are unnecessary to protect co-frequency networks, particularly if the Commission adopts its Option III sharing plan, which limits the interference that NGSO FSS networks can cause to co-frequency systems. Adoption of off-axis e.i.r.p. limits may also restrict unnecessarily the operations of NGSO FSS networks. In contrast to GSO systems, where off-axis e.i.r.p. density at a given angle defines the uplink interference, NGSO orbit characteristics vary over time and therefore require fluctuations in transmit power to maintain system performance. Adoption of overly restrictive e.i.r.p. limits could restrain a network's power levels, even though the network may be in full compliance with the interference limits that are eventually adopted by the Commission to define in-line interference events.

Boeing also notes that the Commission did not propose specific off-axis e.i.r.p. limits in its *NPRM* in this proceeding. If the Commission does decide to adopt off-axis e.i.r.p. limits at a later date, Boeing believes that any proposed limits should be placed on public notice for comment prior to their adoption.

**VIII. THE COMMENTERS IN THIS PROCEEDING HAVE RAISED NO NEW ARGUMENTS THAT WOULD JUSTIFY IMMEDIATE DEMONSTRATION OF COMPLIANCE WITH AGGREGATE LIMITS.**

Two operators of geostationary satellite networks in the Ku-band – PanAmSat and DirecTV – along with a third company, Lockheed Martin, filed comments in this proceeding addressing the need for NGSO FSS networks to comply with the aggregate interference limits

that were adopted by the ITU and the Commission for the protection of co-frequency geostationary satellite networks.

PanAmSat and Lockheed Martin reiterated their previous positions that NGSO FSS operators must immediately demonstrate compliance with the aggregate limits,<sup>24</sup> even though (1) ITU working parties are still finalizing a methodology for demonstrating compliance with aggregate limits and (2) it will be many years (if ever) until more than three NGSO FSS networks attempt to operate co-frequency in the band, raising a potential aggregate interference concern. The Commission addressed adequately the concerns of PanAmSat and Lockheed Martin in Docket Number 98-206, and the issue should not be reopened in this proceeding.

In contrast, DirecTV argues that compliance with aggregate EPFD limits to protect the broadcast satellite service must be made an express condition of the licenses of NGSO FSS systems, as well as any Commission authorization for foreign NGSO FSS systems.<sup>25</sup> Boeing has no objection to DirecTV's request, which appears to be consistent with the Commission's previous conclusions.

## **IX. CONCLUSION**

Boeing supports the spectrum-sharing plan set forth in Option III of the *NPRM* – Avoidance of In-Line Interference Events – as the preferred method of sharing between NGSO FSS systems. The vast majority of NGSO FSS applicants expressed support for the Commission's Option III approach. In fact, every applicant that expressed a preference, indicated that the Option III approach should be used for non-homogeneous satellite networks.

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<sup>24</sup> See *PanAmSat Comments* at 2; *Lockheed Martin Comments* at 2.

<sup>25</sup> See *DirecTV Comments* at 3.



Boeing also opposes any proposal to segment the Ku-band between homogeneous and non-homogeneous satellite networks. Such band segmentation would do nothing to facilitate spectrum sharing since none of the applicants in this proceeding have proposed homogeneous constellations. Band segmentation could also compromise the viability of satellite networks that will need access to all of the available spectrum. Finally, band segmentation is unnecessary since all of the proposed systems can use either satellite diversity or frequency avoidance to operate across the entire band using the Option III approach.

Respectfully submitted,

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